Evaluation of Oleoresin Capsicum (Pepper Spray) Canisters for Chemical Content and Reliability

A program to characterize the chemical compositions and the physical characteristics of pepper spray products has been established in the Analytical Chemistry Division at the request of the NIST Office of Law Enforcement Standards (OLES) and with funding from the National Institute of Justice. A variety of products representing a cross section of those used by law enforcement agencies have been selected for testing. The identities and concentrations of the active ingredients were determined by liquid chromatography/electrospray mass spectrometry and the identities of carriers and propellants by gas chromatography/mass spectrometry. Physical testing includes measurement of the number of one-second bursts in a canister, a range test, a spray pattern test, drop tests, and, for the products that produce fogs, the droplet size. Improved analytical methods have been developed for the determination of the active ingredients.

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Pepper spray is used by law enforcement officers to subdue non-cooperative individuals. The active ingredient in most pepper sprays is oleoresin capsicum (OC), an extract of hot peppers. A family of structurally related compounds called capsaicinoids is responsible for the pungency ("heat") of chili peppers, and these sample compounds are found in OC. Pepper spray is effective 85% to 90% of the time, and its use reduces the number of injuries to officers and suspects, as well as the number of use-of-force complaints. The causes of failures have not been established, but may include low concentrations of the active ingredients, poor delivery, and variable subject response. The goal of this study was to determine the identities and concentrations of the ingredients and to examine the mechanical performance of pepper spray units to establish potential modes of failure and hazards in handling.

Eleven commercial pepper spray products were selected for this study, and 100 canisters of each product were obtained for testing. Each of these products was subjected to a series of physical and chemical tests to evaluate product performance characteristics. Multiple canisters of each product were studied to gauge the consistency of the product.

New instrumentation was developed to support this effort. A test chamber was constructed for physical testing. Semi-automated devices were fabricated and tested for determining canister spray capacity, for performing pattern and range tests, and for performing drop tests. Environmental chambers were constructed for storage of canisters under controlled conditions. Phase Doppler interferometry instrumentation was utilized to measure particle sizes near the point of impact within the test chamber.

The determination of product potency was based upon measurement of eight capsaicinoids by liquid chromatography/mass spectrometry (LC/MS). The carrier and propellant in each product were identified by gas chromatography/mass spectrometry (GC/MS). Significant differences in the levels of active ingredient were observed among the products tested. The percent active ingredient ranged from 0.25% to 2.75% for the products included in this study. Products with similar claims of potency did not necessarily contain comparable levels of capsaicinoids, and in some cases, there was considerable variability in capsaicinoid levels among canisters of the same product. Leakage of propellant and/or pepper spray liquid was observed in some instances during physical tests or during storage at elevated temperature. Differences were also noted between the performance characteristics specified by the manufacturer (e.g., range, number of one-second bursts) and the results actually observed during the study.

Impact: A reliable set of quantitative chemical and physical measurements on a representative set of canisters is expected to provide a basis for determining the most likely causes of failures in the field and to provide a benchmark against which manufacturers can assess the performance of their products. As a result, law enforcement agencies will be better able to make informed product selection decisions.

Future Plans: New tasks funded by OLES to continue this effort will focus on 1) improvement of the reproducibility and accuracy of the range and pattern tests, 2) development of a product testing protocol standard for pepper sprays, and 3) preparation of a Standard Reference Material suitable for use in the chemical analysis of commercial pepper sprays.